METHOD FOR DECREASING MISALIGNMENT OF A PRINTED CIRCUIT BOARD AND A LIQUID CRYSTAL DISPLAY DEVICE WITH THE PRINTED CIRCUIT BOARD

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a liquid crystal display device, more particularly to a liquid crystal display device having a liquid crystal display panel that may decrease the failure of a tape automated bonding (TAB) by decreasing occasions of a printed circuit board (PCB) when a ductile printed circuit board (PCB) misalignment such as a tape carrier package (TCP) and the PCB are bonded by a thermo-compression bonding method.

2. Description of the Related Art

At present, a lot of display devices having minimized sizes and more powerful functions are manufactured as the semiconductor technology rapidly develops. The

cathode ray tube (CRT) widely used for an information display device has some advantages such as high performance and low cost. However, the CRT has disadvantages of its bulky size and poor portability. The liquid crystal display (LCD) device has a smaller size and lighter weight. In addition, the LCD device can operate at low power. Hence the LCD device has been paid much attention as substitute for the CRT and is now used for virtually all the information processing devices.

In general, the LCD device includes a thin film transistor (TFT) substrate, a color filter substrate opposed to the TFT substrate and a liquid crystal display panel having a liquid crystal injected between the TFT substrate and the color filter substrate. The LCD device displays the information by utilizing a light modulation resulting from the variation of the optical property of the liquid crystal.

A plurality of gate lines and a plurality of data lines are intersectably formed on the TFT substrate and thin film transistors for switching device and the picture electrode are formed in the intersected region.

The data line receives the gray voltage selected by a source driving integrated circuit (IC), and then transfers the gray voltage to the liquid crystal. The gate line opens or closes the thin film transistor for switching according to the on/off signal outputted form a gate driving IC. At that time, in order to apply the driving signals to the gate line and the data line, the printed circuit board (PCB) including various semiconductor devices and parts thereon, the driving IC transferring the driving signals to the gate line and the data line and the liquid crystal display panel indicating the information should be connected one after another.

The methods for connecting the liquid crystal panel, the printed circuit board and the driving IC are generally divided into a chip on glass (COG) mounting method and a tape automated bonding (TAB) mounting method.

In the COG mounting method, the liquid crystal display panel is connected to the printed circuit board by using a connector such as a flexible printed circuit (FPC) after the driving IC is mounted on the liquid crystal display panel. Also, in the TAB mounting

method, the liquid crystal display panel is connected to the printed circuit board by using a tape carrier package (TCP) including a tape and the driving IC mounted on the tape.

As for the conventional TAB mounting method, the liquid crystal display panel is connected to the TCP by a thermo-compression bonding process and by using an anisotropic conductive film (ACF) and the printed circuit board is connected to the TCP by a soldering process. However, the pitches of input leads of the TCP should decrease as the number of the input leads of the TCP increases and the size of the TCP is reduced. So the probability of short-circuits between the adjacent input leads of the TCP increases when the printed circuit board and the TCP are combined together by the soldering process. Hence, the printed circuit board and the TCP are now combined together by the thermo-compression bonding process.

FIG. 1 is a plane view for illustrating the conventional liquid crystal display device including the printed circuit board and the tape carrier package bonded together by the thermo-compression bonding process at high temperature.

Referring to FIG. 1, a liquid crystal display panel 10 receives the electrical signal from the outside, and then displays the information thereon. Printed circuit boards 20 and 30 are connected to the liquid crystal display panel 10 and transfer the electrical signal to the liquid crystal display panel 10. Tape carrier packages 40 and 50 connect the liquid crystal display panel 10 to the printed circuit boards 20 and 30 to drive the liquid crystal display panel 10.

The liquid crystal display panel 10 includes a TFT substrate 14 and a color filter substrate 12 facing each other.

A plurality of gate lines (not shown) are disposed on the TFT substrate 14 along the length of the TFT substrate 14 and a plurality of data lines (not shown) are disposed on the TFT substrate 14 along the width of the TFT substrate 14. The gate lines and the data lines are intersecting each other. Gate input pads and data input pads (not shown) are respectively formed on each end of the gate lines and the data lines outside the color filter substrate 12.

The printed circuit board composed of a gate printed circuit board 20 electrically connected to the gate input pads through the TCP 40 and a source printed circuit board 30 electrically connected to the data input pads through the TCP 50.

A gate driving IC 42 and a source driving IC 52 that respectively drive the gate lines and the source lines are formed on the surface of the tape carrier packages 40 and 50.

Hereinafter, it will be described that a method for connecting the liquid crystal display panel 10 to the printed circuit boards 20 and 30 by using the tape carrier packages 40 and 50.

At first, after the anisotropic conductive film is attached to the data pads and the gate pads, the output ends of the tape carrier packages 40 and 50 are positioned on the surface of the anisotropic conductive film, and then the surfaces of the tape carrier packages 40 and 50 are pressed by a thermo-compression device. Thus, the gate pads and the data pads and the output leads (not shown) of the tape carrier packages 40 and

50 are electrically connected while the anisotropic conductive film composed of a thermoplastic resin is completely compressed to the liquid crystal display panel 10 by the thermo-compression device.

Subsequently, after the anisotropic conductive film is attached to the surface of the PCB land group (not shown) formed on the rear surface of the printed circuit boards 20 and 30, the input leads (not shown) of the tape carrier packages 70 and 90 are respectively attached to the rear surfaces of the printed circuit boards 20 and 30 by using the thermo-compression device. Hence, the input leads of the tape carrier packages 40 and 50 are electrically connected to the PCB lands (not shown) of the printed circuit boards 20 and 30 while the anisotropic conductive film is hardened by the heat and the force of the thermo-compression device at high temperature.

In the above-described method, however, thermal expansions of components may misalign the printed circuit boards 20 and 30 from the tape carrier packages 40 and 50, causing bonding failures.

FIG. 2 is a plane view for showing the thermal expansion directions of the printed circuit board and the tape carrier package during the thermo-compression bonding process. FIG. 2 shows the thermal expansions of the source printed circuit board and the tape carrier package in FIG. 1.

As shown in FIG. 2, the printed circuit board 30 is thermally expanded from the point M horizontally dividing the printed circuit board 30 into two portions to both ends thereof. The thermal expansion amount of the printed circuit board 30 is accumulated toward both end portions of the printed circuit board 30 so that the thermal expansion amounts of the end portions have the largest values. Also, the tape carrier package 50 is thermally expanded from the point M' horizontally dividing the tape carrier package 50 into two portions to both ends thereof and the thermal expansion amounts of the end portions have the largest values.

Thus, though the PCB lands group (not shown) of the printed circuit board 30 and the leads of the tape carrier package 50 are aligned to each other before the

thermo-compression process, they get misaligned during the thermo-compression process due to the thermal expansion between the printed circuit board 30 and the tape carrier package 50. They are misaligned most in the right portion (A_1) of a first TCP and the left portion of an eighth TCP (A_2).

In order to reduce the bonding failure between the TAB-IC caused by the misalignment, the thickness of the printed circuit board is increased, or the composition of the printed circuit board is changed. However, those methods do not totally solve the misalignment problem when the pitches between the leads become closer.

SUMMARY OF THE INVENTION

It is therefore a first objective of the present invention to provide a method for bonding a printed circuit board and a tape carrier package, which can decrease the occasions of misalignment due to thermal expansions of the printed circuit board and the tape carrier package when a TAB-IC is bonded by a thermo-compression bonding

method.

It is a second objective of the present invention to provide a liquid crystal display device manufactured according to the above method for bonding the printed circuit board and the tape carrier package to decrease the misalignment.

To accomplish the first objective of the present invention, one preferred embodiment of the present invention provides a method for bonding an adherent member to a printed circuit board comprising the steps of providing the printed circuit board having a substrate and a plurality of a first conductive pattern groups formed at a peripheral portion of the substrate in the direction of the length of the substrate wherein the first conductive pattern group adjusted according to a thermal expansion quantity of the substrate where the first conductive pattern group is positioned, providing the adherent member having a plurality of a second conductive pattern group corresponding to the first conductive pattern group, aligning the adherent member and the printed circuit board, and bonding the adherent member to the printed circuit board

by a thermo-compression bonding method.

Also, to accomplish the second objective of the present invention, another preferred embodiment of the present invention provides a liquid crystal display device including a printed circuit board and a tape carrier package attached to each other by the above-mentioned method.

According to the present invention, when the PCB lands are thermo-compressed with tape carrier packages by mean of shrinking the PCB lands of the printed circuit board by the thermal expansion of the printed circuit board, the misalignment due to the thermal expansion of the printed circuit board can be decreased to sufficiently secure the processing margin, so the productivity can be improved by reducing the processing failure. Also, the degree of misalignment can be uniformly maintained to enhance the control of the misalignment and to increase the stability of the product.

BRIEF DESCRIPTION OF THE DRAWINGS

The above objectives and advantages of the present invention will become more apparent by describing in detail preferred embodiments thereof with reference to the attached drawings:

FIG. 1 is a plane view illustrating a liquid crystal display panel including the conventional printed circuit board and a tape carrier package attached each other.

FIG. 2 is a plane view illustrating expansion directions of the conventional printed circuit board and the tape carrier package during thermo-compression bonding at high temperature.

FIG. 3A is a plane view showing a shrinkage printed circuit board in the pre-compression bonding state according to one embodiment of the present invention.

FIG. 3B is a plane view showing a tape carrier package in the pre-compression bonding state according to one embodiment of the present invention.

FIGs. 4A, 4B, 4C and 4D are graphs illustrating the misalignment of the conventional printed circuit board at various temperatures.

FIG. 5A is a plane view illustrating the thermal expansion of the shrinkage printed circuit board on the basis of the left portions of a first and a eighth tape carrier packages according to the present invention.

FIG. 5B is a plane view illustrating the measurement of misalignment on the A region in FIG. 5A.

FIG. 5C is a plane view illustrating the measurement of misalignment on the B region in FIG. 5A.

FIG. 6A is a plane view illustrating the thermal expansion of the shrinkage printed circuit board on the basis of the right portions of a first and an eighth tape carrier packages according to the present invention.

FIG. 6B is a plane view illustrating the measurement of the misalignment on the A region in FIG. 5A.

FIG. 6C is a plane view illustrating the measurement of the misalignment on the B region in FIG. 6A.

FIG. 7A is a plane view showing a first printed circuit board land and the first tape carrier package in the alignment state after thermal expansion.

FIG. 7B is a plane view showing an eighth printed circuit board land and the eighth tape carrier package in the alignment state after thermal expansion.

FIG. 8A is a graph comparing the experimental data of the shrinkage printed circuit board with the experimental data of the conventional printed circuit board.

FIG. 8B is a graph comparing the experimental data of the misalignment due to the thermal expansion of the shrinkage printed circuit board with the experimental data of the misalignment of the thermal expansion of the conventional printed circuit board.

FIGs. 9A, 9B, 9C, 9D, 9E, 9F, 9G, 9H, 9I and 9J are graphs illustrating the misalignment of each sample on the basis of the central line of the shrinkage printed circuit board according to the table 7.

FIGs. 10A, 10B, 10C, 10D and 10E are graphs illustrating the misalignment of each sample on the basis of the central line of the conventional printed circuit board

according to the table 9.

FIG. 11 is a graph comparing the thermal expansion of each tape carrier package of the shrinkage printed circuit board with the thermal expansion of each tape carrier package of the conventional printed circuit board.

FIG. 12 is a plane view showing a liquid crystal display device including the shrinkage printed circuit board and the tape carrier package bonded to each other by the thermo-compression bonding method at a high temperature according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, the present invention will now be described more fully with reference to the accompanying drawings, in which preferred embodiments of the present invention are shown. The present invention may, however, be embodied in many different forms and should not be construed as being limited to the embodiments

set forth herein.

FIGs. 3A and 3B are plane views showing the printed circuit board and the tape carrier package according to one embodiment of the present invention.

Hereinafter, the minus (-) indicates the displacement toward the left direction and the plus (+) represents the displacement toward the right direction.

Referring to FIG. 3A, a printed circuit board 100 according to the present invention, has a substrate 110 and PCB land group 120 that electrically connects the substrate 110 to outside. Also, a driving circuit is formed on the printed circuit board 100 for operating the liquid crystal display device.

The PCB land group 120 is composed of a plurality of PCB lands 120a through 120h. Each of the PCB lands 120a to 120h is shrunk by a predetermined dimension (hereinafter it is called the shrinkage design) in the direction of a point M dividing the substrate 110 into two parts along the length of the substrate 110. The PCB lands 120a through 120h are defined as a first PCB land 120a to a eighth PCB land 120h span from

the left of the substrate 110. Also, an anisotropic conductive film (ACF) 130 is attached to the upper surfaces of the PCB lands 120a through 120h.

The length of the printed circuit board 100 is generally indicated as the distance from the right end of the eighth PCB land 120h corresponding to a eighth tape carrier package to the left end of the first PCB land 120a corresponding to a first tape carrier package. So the printed circuit board 100 of the present invention has the shrunk length (hereinafter, the printed circuit board 100 is called as a shrinkage printed circuit board), when compared to the conventional printed circuit board.

The shrinkage amount of the shrinkage printed circuit board 100 is determined by the degree of misalignment happening in the conventional printed circuit board according to one embodiment of the present invention. For this purpose, after the conventional printed circuit board having a thickness of about 0.45t was thermo-compressed under a pressure of about 172kgf/cm^2 for about 20 seconds, the degree of misalignment were respectively measured at the left and the right of the TCP as shown

in Table 1. In the thermo-compression bonding process, Sample 1, Sample 2 and Sample 3 were respectively bonded by the thermo-compression bonding method at temperatures of about 415℃, about 405℃, about 415℃ and about 420℃. FIG. 4 illustrates the graphs according to the results shown in Table 1.

Table 1 Degree of misalignment (μm) at each TCP of the conventional printed circuit board at various temperatures.

		TCP1	TCP2	TCP3	TCP4	TCP5	TCP6	TCP7	TCP8
Sample 1	Left	-58	-26	-34	1	13	12	60	63
	Right	-96	-81	-83	-53	-23	-29	13	12
Sample 2	Left	-39	-61	-14	14	17	38	77	66
	Right	-96	-96	-63	-33	-23	-3	18	36
Sample 3	Left	-41	-28	-27	-1	6	14	44	59
	Right	-88	-74	-85	-58	-59	-30	-10	3
Sample 4	Left	-44	-46	-13	52	57	21	81	81
	Right	-93	-97	-47	6	2	-20	26	31

As shown in FIG. 2, in the conventional printed circuit board, the first TCP and the eighth TCP are expanded the most due to the thermal expansion. Referring to FIG.

4, the degree of misalignment tends to increase toward the right upper end and the misalignment occurs a lot in the left of the point M dividing the printed circuit board into the two portions rather than the right of the point M. The reason is that the thermal reaction properties in the left and the right portions of the printed circuit board are different from each other since the conventional printed circuit board is not symmetric in left and right.

Referring to Table 1 and FIG. 4, the TCP 1 and the TCP 8 are misaligned most. The shrinkage of the PCB lands respectively corresponding to the TCP 1 and the TCP 8 can be determined. Hence, the shrinkage printed circuit board 100 is formed by determining the positions of other PCB lands to have constant intervals in the left portion and the right portion of the printed circuit board based on the shrinkage of the PCB lands respectively corresponding to the TCP 1 and the TCP 8.

According to Table 1, the average of the regions where the TCP 1 and the TCP 8 are positioned are –69.375 μm and 43.875 μm, respectively. Also, since the degree of

misalignment in the left portion of the conventional printed circuit board is higher than the right portion of the printed circuit board as shown in FIG. 4, the PCB land 120a corresponding to the TCP 1 200a is shrunk toward the point M by the dimension of about 66.5μ m under the processing allowance of about 2.875 μm and the PCB land 120h corresponding to the TCP 200h is shrunk by the dimension of about 46.5 μm toward the point M under the processing allowance of about 2.125 μm. Thus, so the shrinkage printed circuit board 100 has the shrunk dimension by the length of about 112.5 μm in comparison with the conventional printed circuit board.

Also, the thermal expansion amount of the left portion of the shrinkage printed circuit board 100 is larger than the thermal expansion amount of the right portion of the shrinkage printed circuit board 100 depending on the shape of the shrinkage printed circuit board 100 so that the distances among the PCB lands are set as 19 μm in the left portion of the point M and 13 μm in the right portion of the point M.

Hence, in order to improve this misalignment according to the one embodiment

of the present invention, the dimensions of the PCB lands are shrunk as shown in FIG. 3A so that the shrinkage printed circuit board 100 has the shrunk length by 112.5 μm compared with the length of the conventional printed circuit board.

Referring to FIG. 3B, the TCP unit 200 corresponding to the PCB land group 120 is fixed at the edge portion of the TFT substrate 300 by interposing the ACF 250. The ACF 250 is the medium that electrically connects the TCP unit 200 to the TFT substrate 300. The TCP unit 200 corresponds to the PCB lands 120a through 120h and consists of the first TCP 200a through the eighth TCP 200h from the left of the TCP unit.

The driving IC 220 is disposed at the central portion of the film composed of the light transmitting polyamide and each TCP 200a through 200h includes input lead 230 and output lead 240. The input lead 230 connects the driving IC 220 to the printed circuit board 100 and the output lead 240 connects the driving IC 220 to the TFT substrate 300 by interposing the ACF 250 thereto.

In this case, each of TCP 200a through 200h is formed by a predetermined

interval to align in the position, before each PCB 120a through 120h corresponding to each of the TCP 200a through 200h is shrunk. Hereinafter, the portion of the shrinkage printed circuit board 100 where the input lead 230 and the output lead 240 are installed is called a horizontal portion while the portion of the shrinkage printed circuit board 100 perpendicular to the horizontal portion is called a vertical portion.

In the shrinkage printed circuit board 100 having the above-described construction, the input lead 230 of the TCP 200a through 200h is covered with the ACF 130 of the shrinkage printed circuit board 100 by utilizing a movable stage and a fixing member. At that time, the center of each PCB land 120a through 120h is deviated from the center of each TCP 200a through 200h by the shrinkage amount of each PCB land 120a through 120h, thereby forming a pre-compression state.

In the pre-compression state, the shrinkage printed circuit board 100 and the TCP unit 200 are attached at a predetermined temperature under a predetermined pressure during the thermo-compression bonding process.

At that time, the PCB lands 120a through 120h are expanded toward the left and the right ends of the substrate 110 centering around the point M according to the thermal expansion of the substrate 110 to compensate the shrinkage amount of each PCB land 120a through 120h when the shrinkage printed circuit board 100 is manufactured. Thus, the misalignment is decreased since each PCB 120a through 120h are well aligned to each TCP 200a through 200h.

For verifying the misalignment, the shrinkage printed circuit boards are measured after selecting arbitrary ten shrinkage printed circuit boards and putting them through the thermo-compression bonding process. Each shrinkage printed circuit board has a thickness of about 0.45t and is thermo-compressed at a temperature of about 175℃ under a pressure of about 3MPa for about 20 seconds.

The left and the right thermal expansion directions of the TCP 200a through 200h are different from the thermal expansion direction of the substrate 110. Therefore, individual misalignment occurs to the left and right directions of the TCP 200a through

200h. So the left misalignment of the TCP unit 200 and the right misalignment of the TCP unit 200 are independently measured as shown in Table 2.

Table 2 Misalignment values (μm) measured at each TCP of the shrinkage printed circuit board

		TCP1	TCP2	TCP3	TCP4	TCP5	TCP6	TCP7	TCP8
Sample 1	Left	-28	-9	-21	31	29	33	67	82
	Right	-64	-42	-49	-28	-36	-27	22	38
Sample 2	Left	52	33	45	39	23	27	24	27
	Right	-25	-35	-38	-47	-64	-60	-44	-47
Sample 3	Left	43	36	19	-24	-25	-21	26	20
	Right	-48	-34	-56	-66	-78	-57	-45	-56
Sample 4	Left	43	53	39	46	56	53	53	65
	Right	-29	28	-35	38	31	34	43	24
Sample 5	Left	19	31	-29	24	-35	22	29	32
	Right	-69	-47	-71	-69	-66	-67	-55	-48
Sample 6	Left	-66	-48	-42	-28	-24	-17	12	42
	Right	-113	-85	-79	-76	-67	-57	-44	-15
Sample 7	Left	93	83	59	68	66	75	77	82
	Right	50	54	23	24	-37	28	33	48
Sample 8	Left	47	72	30	29	39	45	46	62
	Right	-33	-44	-58	-59	-56	-52	-44	-27
Sample 9	Left	133	106	102	89	100	88	94	85

	Right	77	72	52	45	43	46	50	37
Sample	Left	24	18	-28	-28	25	26	-45	37
10	Right	-62	-59	-65	-77	-58	-64	-83	-32

Assuming that the thermal expansion increases linearly and the thermal expansion of the tape carrier packages 200a through 200h are constant, the value taken from TCP1 to TCP8 is presumed to be the total thermal expansion of the shrinkage printed circuit board 100.

When the length of the PCB is l_0 before the thermo-compression bonding process and the length of the PCB is l after the thermo-compression bonding process, the thermal expansion amount per unit length is generally expressed as the following equation (1):

$$\frac{l - l_0}{l} \qquad \alpha\Delta t\text{---------------------------------}\ (1)$$

In the above equation (1), α means a thermal expansion coefficient of the PCB

and Δt indicates the difference between the initial temperature and the final temperature. The thermal expansion coefficient, however, depends on the materials when the temperature range is not so wide. Hence, the thermal expansion amount of the PCB increases linearly with a constant rate at all the points of the initial length of the PCB and both ends of the PCB expand the most.

Also, as will be described below, the thermal expansion amounts of the tape carrier packages can be presumed to have constant values concerning the shrinkage printed circuit board 100 or the conventional printed circuit board during the thermo-compression bonding process.

As shown in Table 3, the average value of each thermal expansion amount of each TCP is about 37.3 μm (the standard deviation is 2) when the shrinkage printed circuit board 100 is thermo-compressed. Also, the average value of each thermal expansion amount of each TCP is about 42.17μm (the standard deviation is 0.988) when the conventional printed circuit board is thermo-compressed as shown in Table 7.

According to the above-mentioned assumption, the difference between the measured thermal expansion amount of the first TCP 200a and the measured thermal expansion amount of the eighth TCP 200h, both tape carrier packages 200a and 200h respectively locating at end portions of the shrinkage printed circuit board 100, is presumed to be the total thermal expansion amount of the shrinkage printed circuit board 100. Such presumption will be described with reference to FIGs. 5 and 6 as follows. Hereinafter, the left misalignment is measured based on each left portion of each TCP and the right misalignment is measured based on each right portion of each TCP.

FIGs. 5A, 5B and 5C are plane views illustrating the presumption of the total thermal expansion amount of the shrinkage printed circuit board 100 concerning the measured misalignment amounts on the basis of the left portions of the first TCP 200a and the eight TCP 200h.

Referring to FIG. 5A, the expansion direction of the first TCP 200a is identical to

the expansion direction of the shrinkage printed circuit board 100. However,, the expansion direction of the eight TCP 200h is opposite to the expansion direction of the shrinkage printed circuit board 100. FIG. 5B is a plane view illustrating the measurement of the misalignment of the A region in FIG. 5A. FIG. 5C is a plane view illustrating the measurement of the misalignment of the B region in FIG. 5A.

In FIG. 5B, a first real line 410 means the left end of the first PCB land 120a in the pre-compression state and a second real line 510 indicates the left portion of the first TCP 200a in the pre-compression state. Thus, the distance between the first real line 410 and the second real line 510 corresponds to the pre-adjustment made in the pre-compression state by shrinking the position of the first PCB land 120a toward the point M.

When the pre-compression process is performed concerning the first TCP 200a and the first PCB land 120a, the left end of the first PCB land 120a moves toward a first dotted line 420 due to the thermal expansion of the substrate 100 and the left portion of

the first TCP 200a also moves toward the second dotted line 520 for the same reason. Hence, after the thermo-compression bonding process, the first TCP 200a is expanded by an interval (V_1) between the second real line 510 and the second dotted line 520. Also, the first PCB land 120a expands by an interval (P_1) between the first real line 410 and the first dotted line 420. Then, the measured misalignment value becomes the interval (A_1) from the second dotted line 520 to the first dotted line 420. Therefore, the magnitude of the misalignment (A_1) measured at the left portion of the first TCP 200a is expressed according to the following equation (2):

$$A_1 = -P_1 - (-V_1) \text{ -------------------------- } (2)$$

In Table 2, since the left misalignment value of the first TCP 200a is –28, the left end of the first PCB land 120a is positioned at a position departed from the left portion of the first TCP 200a by about 28 μm toward the left direction after thermal expansion of the substrate 100.

In FIG. 5C, the first real line 610 means the left end of the eighth PCB land 120h

in the pre-compression state and the second real line 710 indicates the left portion of the eighth TCP 200h in the pre-compression state. Thus, the distance between the first real line 610 and the second real line 710 corresponds to the pre-adjustment made in the pre-compression state by shrinking the position of the eighth PCB land 120h toward the point M.

When the pre-compression process is performed concerning the eighth TCP 200h and the eighth PCB land 120h, the left end of the eighth PCB land 120h moves toward the first dotted line 620 due to the thermal expansion of the substrate 100 and the left portion of the eighth TCP 200h also moves toward the second dotted line 720 due to the thermal expansion of the substrate 100. Hence, after the thermo-compression bonding process, the eighth TCP 200h is expanded by an interval (V_8) between the second real line 710 and the second dotted line 720. The eighth PCB land 120h also expands by an interval (P_8) between the first real line 610 and the first dotted line 620. Also, the measured misalignment value becomes the interval (A_8) from the

second dotted line 720 to the first dotted line 620. Therefore, the magnitude of the misalignment (A_8) measured at the left portion of the eighth TCP 200h is expressed according to the following equation (3):

$$A_8 = P_8 - (-V_8) \text{ --------------------------- } (3)$$

In Table 2, since the left misalignment value of the eighth TCP 200h is 82, the left end of the eighth PCB land 120h is positioned at a position departed from the left portion of the eighth TCP 200h by about 82 μm in the right direction after thermal expansion of the substrate 100.

Hence, the following equation (4) can be obtained by taking the equation (2) from the equation (3):

$$A_8 - A_1 = P_8 + P_1 \text{ --------------------------- } (4)$$

Therefore, the difference between the misalignment values measured at the left portions of the first TCP 200a and the eighth TCP 200h is regarded as the total thermal expansion amount of the shrinkage printed circuit board 100 generated during the

thermo-compression bonding process.

Figs. 6A, 6B, and 6C are plane views illustrating the presumption of the total thermal expansion amount of the shrinkage printed circuit board 100 concerning the measured misalignment amounts based on the right portions of the TCP unit 200.

Referring to FIG. 6A, the expansion direction of the first TCP 200a is opposite to the expansion direction of the shrinkage printed circuit board 100. However, the expansion direction of the eighth TCP 200h is identical to the expansion direction of the shrinkage printed circuit board 100. FIG. 6B is a plane view illustrating the measurement of the misalignment of the C region in FIGs. 6A and 6C is a plane view illustrating the measurement of the misalignment of the D region in FIG. 6A.

In FIG. 6B, the first real line 430 means the right end of the first PCB land 120a, in the pre-compression state and the second real line 530 indicates the right portion of the first TCP 200a in the pre-compression state. Thus, the distance between the first real line 430 and the second real line 530 corresponds to the pre-adjustment made in

the pre-compression state by shrinking the position of the first PCB land 120a toward the point M.

When the pre-compression process is performed concerning the first TCP 200a and the first PCB land 120a, the right end of the first PCB land 120a moves toward the first dotted line 440 due to the thermal expansion of the substrate 100 and the right portion of the first TCP 200a also moves toward the second dotted line 540 for the same reason. Hence, after the thermo-compression bonding process, the first TCP 200a expands by an interval (W_1) between the second real line 530 and the second dotted line 540 and the first PCB land 120a, corresponding to the first TCP 200a, expands by an interval (P_1) between the first real line 430 and the first dotted line 440. T hen, the measured misalignment value becomes the interval (B_1) from the second dotted line 540 to the first dotted line 440. Therefore, the magnitude of the miss-alignment (B_1) measured at the right portion of the first TCP 200a is expressed according to the following equation (5):

$$B_1 = -P_1 - (W_1) \text{ ---------------------------- } (5)$$

In Table 2, since the right misalignment value of the first TCP 200a is -64, the right end of the first PCB land 120a is positioned at a position departed from the right portion of the first TCP 200a by about 64 μm in the left direction after thermal expansion of the substrate 100.

In FIG. 6C, the first real line 630 means the right end of the eighth PCB land 120h in the pre-compression state and the second real line 730 indicates the right portion of the eighth TCP 200h in the pre-compression state. Thus, the distance between the first real line 630 and the second real line 730 corresponds to the preadjustment made in the pre-compression state by shrinking the position of the eighth PCB land 120h toward the point M.

When the pre-compression process is performed on the eighth TCP 200h and the eighth PCB land 120h corresponding to the eighth TCP 200h, the right end of the eighth PCB land 120h moves toward the first dotted line 640 due to the thermal

expansion of the substrate 100 and the right portion of the eighth TCP 200h also moves toward the second dotted line 740 for the same reason. Hence, after the thermo-compression bonding process, the eighth TCP 200h is expanded by an interval (W_8) between the second real line 730. The second dotted line 740 and the eighth PCB land 120h expands by an interval (P_8) between the first real line 630 and the first dotted line 640. Also, the measured misalignment value becomes the interval (B_8) from the second dotted line 740 to the first dotted line 640. Therefore, the magnitude of the misalignment (B_8) measured at the right portion of the eighth TCP 200h is expressed according to the following equation (6):

$$B_8 = P_8 - (W_8) \text{ -------------------------- } (6)$$

In Table 2, since the right misalignment value of the eighth TCP 200h is 38, the right end of the eighth PCB land 120h is positioned at a position departed from the right portion of the eighth TCP 200h by about 38 μm in the right direction after the thermal expansion of the substrate 110.

Hence, the following equation (7) can be obtained by taking the equation (5) from the equation (6):

$$B_8 - B_1 = P_8 + P_1 \text{ -------------------------- } (7)$$

Therefore, the difference between the misalignment values measured at the right portions of the first TCP 200a and the eighth TCP 200h is regarded as the total thermal expansion amount of the shrinkage printed circuit board 100 generated during the thermo-compression bonding process.

FIGs. 7A and 7B are plane views showing the relative position between the PCB land and the TCP concerning Sample 1 in Table 2 after the thermo-compression bonding process. FIG. 7A is a plane view illustrating the alignment state between the first PCB land and the first TCP and FIG. 7B is a plane view showing the alignment state between the eighth PCB land and the eighth TCP.

Referring to FIGs. 7A and 7B, the total thermal expansion amount of the shrinkage printed circuit board 100 is directly obtained by taking the measured

misalignment value of the eighth TCP 200h from the measured misalignment value of the first TCP 200a.

In this case, though the thermal expansion occurs in the same shrinkage printed circuit board, the thermal expansion amount on the left of the TCP unit (see the equation (4)) differs from the thermal expansion amount on the right of the TCP unit (see the equation (7)). Due to the asymmetry of the shrinkage printed circuit board 100 about the point M, such difference may cause the minute difference among the TCP unit 200 presumed acceptable as they have identical values and the difference among the thermal reaction properties of the TCP unit, causes processing errors.

Consequently, the thermal expansion amounts of each sample in Table 2 can be presumed according to the equation 4 and 7, and the presumed thermal expansion amounts are shown at column A in Table 3.

Table 3 presumed thermal expansion (μm) of the shrinkage printed circuit board and the misalignment amount (μm) of the shrinkage printed circuit board according to the presumed thermal expansion.

		A	B	C	D	E	F
Sample 1	Left	110	277114	92	18	9	130
	Right	102			10	5	122
Sample 2	Left	-25	277020	-2	-23	-12	89
	Right	-22			-20	-10	92
Sample 3	Left	-23	277015	-7	-16	-8	96
	Right	-8			-1	-1	111
Sample 4	Left	22	277008	-14	36	18	148
	Right	53			67	34	179
Sample 5	Left	13	277020	-2	15	8	127
	Right	21			23	12	135
Sample 6	Left	108	277084	62	46	23	158
	Right	98			36	18	148
Sample 7	Left	-11	277013	-9	-2	-1	110
	Right	-2			7	4	119
Sample 8	Left	15	277020	-2	17	9	129
	Right	6			8	4	120
Sample 9	Left	-48	276967	-55	7	4	119
	Right	-40			15	8	127
Sample 10	Left	13	277020	-2	15	8	127
	Right	30			32	26	144

Meanwhile, since the conventional printed circuit board is designed as it has the

standard length of 277134 μm after the standardized process, the shrinkage printed circuit board 100 having the position of the PCB land group shrunk by 112.5 μm has the standard length of 277022 μm after the standardized process in comparison with the conventional printed circuit board. Hereinafter, the shrinkage printed circuit board will be called as the standard printed circuit board when shrinkage printed circuit board goes through the standardized process.

The measured lengths of the shrinkage printed circuit boards 100 for experiment are shown at column B in Table 3 and the length deviations of the PCB are presented by taking the standard length from the measured length of the shrinkage printed circuit boards 100 at column C in Table 3.

In general, the length deviation of the PCB is known that it affects the misalignment regarding of the shrinkage design. Therefore, the PCB allowance control should be needed in the range of ±70 μm concerning the product having the pitch of above 400 μm and the PCB allowance control should be needed in the range of ±50

μm concerning the product having the pitch of below 400 μm. Hence, Sample 1 is deviated from the allowance, judging from the basis of the PCB allowance having the above range.

The thermal expansion amounts of the shrinkage printed circuit board 100 are presented at column D in Table 3 after the length deviations of the PCB are amended. The length deviations of the PCB numerically affect the misalignment. So the value obtained by taking the length deviations at the column C from the expansion amount at column A means the total thermal expansion amount of the shrinkage printed circuit board 100, when the shrinkage printed circuit board 100 for each sample has a standard length.

Also, the shrinkage printed circuit board 100 can be treated as it has the length deviation of about 112.5 μm comparing with the conventional printed circuit board so that the presumed thermal expansion amount can be obtained about the conventional printed circuit board when the initial shrinkage amount of 112.5 μm is added to the total

expansion amount at column D. Such presumed thermal expansion amounts are presented at column E in Table 3.

In the meantime, when the standard shrinkage printed circuit board is thermo-compressed, the misalignment only depending on the thermal expansion of the printed circuit board corresponds to the value obtained by halving the total thermal expansion amount in case of neglecting deviation of the instruments, expansion of the tape carrier package and other factors. The reason is that the thermal expansion of the printed circuit board occurs in the left and the right directions centering around the point M. The misalignment values of the shrinkage printed circuit board 100 having the standard length are shown at column E in Table 3.

Therefore, when the shrinkage printed circuit board 100 of the present embodiment is thermo-compressed, the standard deviation is about 2.64 and the average misalignment of 7.9 μm is occurred. Also, if the conventional standard printed circuit board is not shrunk, the average thermal expansion amount becomes about 127

expansion amount at column D. Such presumed thermal expansion amounts are presented at column E in Table 3.

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μm.

Meanwhile, in order to compare the improvement of the misalignment generated in the shrinkage printed circuit board, the misalignment values are measured at the left and the right portions of the TCP after sampling the conventional printed circuit boards. Such experiments are performed on 5 conventional printed circuit boards. The composition and the thickness of the conventional printed circuit board are identical to those of the shrinkage printed circuit board and the processing conditions and the signs for the conventional printed circuit board are also identical to those for the shrinkage printed circuit board. The measured misalignment values from the experiment are shown in the following Table 4.

Table 4 The misalignment values (μm) measured at each TCP of the conventional printed circuit board

		TCP1	TCP2	TCP3	TCP4	TCP5	TCP 6	TCP 7	TCP8
Sample 1	Left	-34	-29	-30	-21	-25	-26	33	42

		TCP1	TCP2	TCP3	TCP4	TCP5	TCP 6	TCP 7	TCP8
	Right	-88	-59	-62	-71	-66	-63	-54	-50
Sample 2	Left	-68	-66	-53	-47	-33	35	46	45
	Right	-110	-101	-85	-84	-78	-50	-39	-49
Sample 3	Left	-44	-42	-41	-30	-16	31	27	53
	Right	-83	-79	-67	-67	-69	-54	-48	-39
Sample 4	Left	-67	-61	-30	-48	-39	-35	-22	33
	Right	-111	-108	-69	-81	-83	-77	-71	-53
Sample 5	Left	-55	-48	-39	-29	26	37	34	35
	Right	-103	-89	-72	-72	-64	-53	-52	-57

The values obtained by taking TCP 1 from TCP 8 is presumed as the total thermal expansion amount of the conventional printed circuit board such as the shrinkage printed circuit board. The calculated misalignment amounts of the conventional printed circuit board are presented in Table 5 based on the measured misalignment values in Table 4.

Table 5 presumed thermal expansion (μm) of the conventional printed circuit board and the misalignment amount (μm) of the conventional printed circuit board according to the presumed thermal expansion.

		A	B	C	D	E
Sample 1	Left	76	277058	-76	152	76
	Right	38			114	57
Sample 2	Left	113	277104	-30	143	72
	Right	61			91	46
Sample 3	Left	97	277091	-43	140	70
	Right	50			93	47
Sample 4	Left	100	277089	-45	145	73
	Right	58			103	52
Sample 5	Left	90	277096	-38	128	64
	Right	46			84	42

In Table 5, column A means the thermal expansion amounts of the conventional printed circuit board presumed from the measured misalignment values in Table 4 and column B indicates the measured lengths of the samples utilized during the experiment. Column C means the values obtained by the standard length of the conventional printed circuit board (that is, 277134 μm) from the measured lengths and represents the length deviations concerning the conventional printed circuit board.

Hence, the thermal expansion amounts amended by the length deviations of the PCB about the samples of the conventional printed circuit board correspond to the values obtained by taking the values of the column C from the values of column A. Such presumed thermal expansion amounts are shown at column D in Table 5 and the conventional printed circuit board expands by the average thermal expansion amount of 119 μm while the standard deviation is 25.4.

The misalignment due to the thermal expansion of the conventional printed circuit board are presented at column E in Table 5. Since the thermal expansion of the conventional printed circuit board occurs in the left and the right directions centering around the half point M, the misalignment amounts correspond to one half of the presumed thermal expansion amount at the column D, And the average misalignment amount is about 60 μm while the standard deviation is 4.0.

Therefore, if the misalignment amount due to the thermal expansion of the shrinkage printed circuit board of the present embodiment in Table 3 is compared with

the misalignment amount due to the thermal expansion of the conventional printed circuit board in Table 5, the decrease in misalignment according to the present embodiment can be clearly verified.

According to the present embodiment, the decrease in misalignment is verified at a temperature of 175°C. But, the decrease in misalignment is of course verified in a temperature range that the thermal expansion of the printed circuit board is largely generated. An epoxy, with which the printed circuit board is made, is generally transformed into a glass at a temperature about 140°C (transition temperature of the PCB), and therefore, the decrease in misalignment is always verified in a thermo-compression bonding process performed at a temperature more than the transition temperature of the PCB. However, at a temperature more than 200°C, adhesive force is remarkably lowered because of an over-hardness characteristic of the ACF film. Consequently, the decrease of the misalignment is conspicuously verified in a range of the temperature between 140°C and 200°C.

FIGs. 8A and 8B are graphs comparing the experimental data of the shrinkage printed circuit board of the present invention with the experimental data of the conventional printed circuit board. FIG. 8A is a graph comparing the thermal expansion amount of the shrinkage printed circuit board of the present invention with the thermal expansion amount of the conventional printed circuit board. FIG 8B is a graph comparing the misalignment amount due to the shrinkage printed circuit board of the present invention with the misalignment amount due to the conventional printed circuit board.

Referring to FIG. 8A, column D in Table 5 and column A in Table 3, the average thermal expansion amount of the conventional printed circuit board is about 119 μm and the average thermal expansion amount of the shrinkage printed circuit board is about 127 μm, so both thermal expansion amounts have similar values. Hence, it is identified that the shrinkage of the substrate length does not much affect the thermal expansion of the substrate.

Referring FIG. 8B, column D in Table 5 and column A in Table 3, however, the improvement effect of the misalignment due to the thermal expansion of the substrate can be identified. While the average misalignment amount of the conventional standard printed circuit board is 60 μm, the average misalignment amount of the shrinkage standard printed circuit board is 7.9 μm to verify the great improvement of the misalignment in the shrinkage standard printed circuit board according to the present invention.

Meanwhile, the thermal expansion amount of the printed circuit board is accumulated toward both left and right end portions of the printed circuit board, so the generated misalignment amount is increased toward both left and right end portions of the printed circuit board. Such intention is already identified as the inclination is increased toward the right ends of the graphs in FIG. 4.

In the shrinkage printed circuit board 100 according to the present invention, the intervals among the PCB lands at the left and the right portions of the substrate 110

centering around the point M are differently set one after another, thereby constantly maintaining the misalignment amount generated in each of TCP 200a through 200h. The constant misalignment amount will be identified as follows by utilizing the measured data in Tables 2 and 4.

In Table 2, the misalignment amount is measured on the basis of each edge of TCP 200a through 200h for the convenience of the measurement. However, the precise misalignment amount should be measured on the basis of each PCB land 120a through 120h and the center of each lead of TCP 200a through 200h because the misalignment means the irregularity among conductive patterns for exchanging the electrical signals between the printed circuit board and the tape carrier package.

Therefore, after the widths of each PCB land 120a through 120h and each TCP lead 200a through 200h are measured, the calculated misalignment values on the basis of the center of each TCP lead 200a through 200h are presented in Table 7. In the samples of shrinkage printed circuit board, the measured width of each PCB land 120a

to 120h and the measured width of each TCP lead 200a to 200h are shown in the following Table 6.

Table 6 The widths (μm) of the PCB land and the TCP lead of the shrinkage printed circuit board

	measured width of land (a)	width of lead (b)	(a – b)/2
Sample 1	195	170	12.5
Sample 2	215		22.5
Sample 3	215		22.5
Sample 4	215		22.5
Sample 5	220		25
Sample 6	200		15
Sample 7	220		25
Sample 8	220		25
Sample 9	220		25
Sample 10	215		22.5

As shown in Table 6, the measured width of the land is obtained by measuring the real width of the PCB land of each sample and the width of the lead is obtained by measuring the real width of the TCP lead of each sample. The widths of the leads are

minutely various so that the width of the leads are treated as constants for all the samples.

Thus, though the difference between the measured width of the land and the width of the lead (hereinafter, it is called the width difference) is the value having no connection with the misalignment, the width difference is included in the measured misalignment value in Table 2. The measured misalignment values in Table 2 are obtained on the basis of each TCP 200a through 200h and each TCP 200a through 200h is thermally expanded in the left and the right directions centering around the point dividing each TCP 200a through 200h into two portions in the lengthwise direction of each TCP 200a through 200h. So two halves of the width difference are respectively included in the left and the right portions of each TCP 200a through 200h centering around the point dividing each TCP lead into two portions in the lengthwise direction of each TCP lead.

Therefore, the value obtained by halving the width difference from the measured

misalignment value corresponds to the misalignment value generated on the basis of the center of each TCP 200a through 200h. In Table 2, half the width difference is added to the measured misalignment value in the left direction and half the width difference is taken from the measured misalignment value in the right direction, so the absolute misalignment value is reduced by half the width difference compared with the measured misalignment value in Table 2. The calculated misalignment values on the basis of the center of the shrinkage printed circuit board obtained the above method are shown in Table 7.

Table 7 the misalignment values (μm) on the basis of the center of the shrinkage printed circuit board

		TCP1	TCP2	TCP3	TCP4	TCP5	TCP6	TCP7	TCP8
Sample 1	Left	-16	4	-9	19	17	21	55	70
	Right	-52	-30	-37	-16	-24	-15	10	26
Sample 2	Left	30	11	23	17	1	5	2	5
	Right	-3	-13	-16	-25	-42	-38	-22	-25
Sample 3	Left	21	14	-4	-2	-3	2	4	-3
	Right	-26	-12	-34	-44	-56	-35	-23	-34

		TCP1	TCP2	TCP3	TCP4	TCP5	TCP6	TCP7	TCP8
Sample 4	Left	21	31	17	24	34	31	31	43
	Right	-7	6	-13	13	9	12	21	2
Sample 5	Left	-6	6	-4	-1	-10	-3	4	7
	Right	-44	-22	-46	-44	-41	-42	-30	-23
Sample 6	Left	-51	-33	-27	-13	-9	-2	-3	27
	Right	-98	-70	-64	-61	-52	-42	-29	0
Sample 7	Left	68	58	34	43	41	50	52	57
	Right	25	29	-2	-1	-12	3	8	23
Sample 8	Left	22	47	5	4	14	20	21	37
	Right	-8	-19	-33	-34	-31	-27	-19	-2
Sample 9	Left	108	81	77	64	75	63	69	60
	Right	52	47	27	20	18	21	25	12
Sample 10	Left	2	-5	-6	-6	3	4	-23	15
	Right	-40	-37	-43	-55	-36	-42	-61	-10

The following Table 9 shows the misalignment values amended on the basis of the center of each TCP lead by using the misalignment amounts measured on the basis of the end portions of each TCP in Table 4 according to the above-described method. In this case, the measured values of each PCB land and each TCP lead are presented in

Table 8.

Table 8 The widths (μm) of the PCB land and the TCP lead of the conventional printed circuit board

	measured width of land (a)	width of lead (b)	(a – b)/2
Sample 1	210	170	20
Sample 2	215		22.5
Sample 3	210		20
Sample 4	210		20
Sample 5	210		20
Sample 6	220		25

Table 9 The misalignment values (μm) on the basis of the center of the conventional printed circuit board

		TCP1	TCP2	TCP3	TCP4	TCP5	TCP6	TCP7	TCP8
Sampl	Left	-14	-9	-10	-1	-5	-6	13	22
e 1	Right	-68	-39	-42	-51	-46	-43	-34	-30
Sampl	Left	-46	-44	-31	-25	-11	13	23	23
e 2	Right	-88	-79	-63	-62	-56	-28	-17	-27
Sample	Left	-24	-22	-21	-10	4	11	7	33
3	Right	-63	-59	-47	-47	-43	-34	-28	-13
Sampl	Left	-47	-41	-10	-28	-19	-15	-2	13

		TCP1	TCP2	TCP3	TCP4	TCP5	TCP6	TCP7	TCP8
e 4	Right	-91	-88	-49	-61	-63	-57	-51	-33
Sample	Left	-35	-28	-19	-9	6	17	14	15
5	Right	-83	-69	-52	-52	-44	-33	-32	-37
Sample	Left	-38	-11	-20	-3	12	15	37	52
6	Right	-79	-56	-56	-43	-27	-29	-7	6

FIGs. 9A through 9I are graphs for showing the misalignment values in Table 7 and each graph illustrates the misalignment of each sample on the basis of the center of each sample.

While the graphs of FIGs. 10A through 10E show the misalignment amounts of the conventional printed circuit board generally having the inclinations toward the right ends of the graphs, the graphs of FIGS. 9A through 9I show the misalignment amounts of the shrinkage printed circuit board samples according to the present invention approximately having the inclination parallel to the axis indicating the TCP.

Hence, the intervals among the PCB lands at the left portion of the shrinkage

printed circuit board 100 are differently set from the intervals among the PCB lands at the right portion of the shrinkage printed circuit board 100, thereby maintaining the magnitudes of the misalignment generated in each TCP 200a through 200h to have constant values after the thermo-compression bonding process. Also, it can be prevented that the excessive thermal expansions of each TCP 200a through 200h generated by accumulating the thermal expansion in the first TCP 200a and the eighth TCP 200h.

In the meantime, the misalignment values in Tables 7 and 9 are generated on the basis of the center of each TCP 200a through 200h, so the difference between the left misalignment value and the right misalignment value in the same TCP corresponds to the thermal expansion amount generated during the thermo-compression bonding process for the TCP. Thus, Tables 10 and 11 show the thermal expansion amount of each TCP 200a through 200h calculated by utilizing the data in Tables 7 and 9 concerning the shrinkage printed circuit board and the conventional printed circuit board.

Table 10 The thermal expansion amounts (μm) of the TCP in the shrinkage printed circuit board

	TCP1	TCP2	TCP3	TCP4	TCP5	TCP6	TCP7	TCP8	Average
Sample 1	36	33	28	34	40	35	45	44	37
Sample 2	32	23	38	41	42	42	23	29	34
Sample 3	46	25	30	42	53	36	26	31	36
Sample 4	27	25	29	8	25	19	10	41	23
Sample 5	38	28	42	43	31	39	34	30	36
Sample 6	47	37	37	48	43	40	26	27	38
Sample 7	43	29	36	44	53	47	44	34	41
Sample 8	30	66	38	38	45	47	40	39	43
Sample 9	56	34	50	44	57	42	44	48	47
Sample 10	41	32	37	49	38	45	38	24	38

Table 11 the thermal expansion amounts (μm) of the TCP in the conventional printed circuit board

	TCP1	TCP2	TCP3	TCP4	TCP5	TCP6	TCP7	TCP8	Average
Sample 1	54	38	32	50	41	37	47	52	43.875
Sample 2	42	35	32	37	45	40	39	49	39.875
Sample 3	39	37	26	37	47	45	35	46	39
Sample 4	44	47	39	33	44	42	49	46	43
Sample 5	48	41	33	43	50	50	46	52	45.375

	TCP1	TCP2	TCP3	TCP4	TCP5	TCP6	TCP7	TCP8	Average
Sample 6	41	45	36	40	39	44	44	46	41.875

As shown in Table 10, the average thermal expansion amount generated in the TCP is about 37 μm during the thermo-compression bonding process for the shrinkage printed circuit board and the standard deviation is 9.9. However, the average thermal expansion amount generated in the TCP is about 42 μm during the thermo-compression bonding process for the conventional printed circuit board and the standard deviation is 6.4.

FIGs. 9A through 9I are the graphs comparing the results in Table 10 with the results in Table 11.

Referring to FIGs. 9A through 9I, Tables 10 and 11, assume that the tape carrier packages expand uniformly unlike the conventional printed circuit board and also the expansion of the printed circuit board and the expansion of the tape carrier package are independent from each other. The uniform expansion of the tape carrier package is

already mentioned in the above description for the shrinkage printed circuit board as assumption according to the present invention.

According to the data in Tables 10 and 11, the average expansion amount of each TCP 200a through 200h is about 40 μm and the misalignment amount due to the expansion of each TCP 200a through 200h is about 20 μm. Since the printed circuit board and the tape carrier package expand independently from each other, the shrinkage design for the tape carrier package should be considered, separate from the shrinkage design for the printed circuit board.

Hence, when the shrinkage printed circuit board 100 and the tape carrier package are combined by the thermo-compression bonding process, the occasions of misalignment due to the thermal expansion of the printed circuit board can be remarkably reduced, thereby increasing the productivity by reducing the failure during the bonding process.

As for the above-described embodiment of the present invention, though the

printed circuit board is combined with the tape carrier package, a ductile circuit board can be used instead of the tape carrier package and also the numbers of the PCB land and the tape carrier package may be arbitrarily selected according to their uses and functions.

FIG. 12 is a plane view showing the liquid crystal display panel including the shrinkage printed circuit board and the tape carrier package combined together by the thermo-compression bonding process at high temperature.

Referring to FIG. 12, the liquid crystal display panel 50 receives the electrical signal from outside and displays the information, the shrinkage printed circuit boards 60, 80 connected to the liquid crystal display panel 50 transfers the electrical signal to the liquid crystal display panel 50, and the tape carrier packages 70, 90 connects the liquid crystal display panel 50 to the shrinkage printed circuit boards 60, 80 to operate the liquid crystal display panel 50.

The liquid crystal display panel 50 includes the thin film transistor substrate 52

and the color filter substrate 51 facing the thin film transistor substrate 52.

A plurality of gate lines (not shown) are disposed in a line on the thin film transistor substrate 52 along the width of the thin film transistor substrate 52 and a plurality of data lines (not shown) are disposed in a line to intersect the gate lines. The data lines are disposed on the thin film transistor substrate 52 along the length of the thin film transistor substrate 52. Data input pads and gate input pads are respectively formed on the gate and the data lines exposed from the color filter substrate 51.

The shrinkage printed circuit boards 60 and 80 are composed of the source shrinkage printed circuit board 60 electrically connected to the data input pads by means of the tape carrier package 70 and the gate shrinkage printed circuit board 90 electrically connected to the gate input pads by means of the tape carrier package 90.

The data driving integrated circuit (IC) 72 and the source driving IC 92 for driving the data and the gate lines are formed on the surface of the tape carrier packages 70 and 90.

It will be described that the method for connecting the shrinkage printed circuit boards 60 and 80 to the liquid crystal display panel 50 by means of the tape carrier packages 70 and 90.

At first, after the anisotropic conductive film (not shown) is attached to the data and the gate input pads, the output ends of the tape carrier packages 70 and 90 are positioned on the surface of the anisotropic conductive film, and then the surfaces of the tape carrier packages 70 and 90 are pressed by using a thermo-compression device. Thus, the gate and the data input pads and the output leads (not shown) are electrically connected while the anisotropic conductive film composed of the thermoplastic resin is completely compressed to the liquid crystal display panel 50 by the thermo-compression device.

Subsequently, after the anisotropic conductive film is attached to the surface of the PCB land group formed on rear surface of the shrinkage printed circuit boards 60 and 80, the input leads (not shown) of the tape carrier packages 70 and 90 are attached

to the rear surfaces of the shrinkage printed circuit boards 60 and 80 by using the thermo-compression device. Hence, the input leads of the tape carrier packages 70 and 90 are electrically connected to the PCB lands (not shown) of the shrinkage printed circuit boards 60 and 80, while the anisotropic conductive film is hardened by the heat and the force of the thermo-compression device at high temperature.

At that time, as it is described above, the misalignment amounts between the shrinkage printed circuit boards 60 and 80 and the tape carrier packages 70 and 90 corresponding to the shrinkage printed circuit boards 60 and 80 are uniformly generated and the average misalignment value becomes 8μm.

After the back light assembly is installed beneath the liquid crystal display panel 50, the liquid crystal display device is completed by fixing the liquid crystal display panel and the back light assembly to the mold frame.

According to the present invention, when the PCB lands are thermo-compressed with tape carrier packages by shrinking the PCB lands of the printed circuit board by the

thermal expansion of the printed circuit board, the misalignment due to the thermal expansion of the printed circuit board can be decreased to sufficiently secure the processing margin, so the productivity can be improved by reducing the processing failure. Also, the misalignment amount can be uniformly maintained to enhance the probability for controlling the misalignment and to increase the stability of the product.

While the present invention has been particularly shown and described with reference to preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and detail may be effected therein without departing from the spirit and scope of the invention as defined by the appended claims.